REMARKS

Applicants thank Examiner Paik for conducting the kind and courteous discussion with Applicants' undersigned representative, Daniel R. Evans, and Mr. Takeo Niwa of Ibiden Co., Ltd. The content of the discussion is reflected in the amendments to the claims and the comments contained herewith. It is kindly requested that the Examiner reconsider the outstanding rejections in view of the following comments.

The claimed invention is directed at solving a problem of uniformly heating a semiconductor substrate by means of a hot plate. The general design of a hot plate is known. At least one resistance element is coupled to an insulating substrate; wherein the heat emanated from the resistance element is transmitted through the insulating substrate to the semiconductor substrate. A problem that occurs is that the semiconductor substrate is not heated uniformly. This can be problematic when the semiconductor substrate is coated with, for example, a precursor photosensitive material, in which the heating is necessary to develop said material. If the rate of material development is proportional to the developing temperature and if the developing temperature is non-uniform, then non-uniform heating may result in a non-uniformly developed material. This, in turn, may cause problems either in production or in performance of the final product. Accordingly, it is desirable to be able to transmit heat uniformly through the insulating substrate.

The inventors have studied this problem and have disclosed in the present application a solution, which reduces non-uniform transmission of heat from the resistance element through the insulating substrate to the semiconductor substrate. The inventors have observed that acceptable uniform heating of a semiconductor substrate occurs when the observed thickness dispersion of the resistance element is $\pm$ 3 μm. It is believed that uniform temperature transmission is made possible, in part or in whole, by forming a resistance

element on a surface of an insulating substrate, in which the surface of the insulating substrate has a surface roughness of 2 μm or less. This fundamental discovery is believed to serve as a cornerstone for novelty and unobviousness over the disclosures of the cited references.

Three aspects of the present invention are presented as follows:

(1) A process for producing a hot plate comprising an insulating substrate having an upper face and a lower face having a surface roughness of 2 μm or less and a resistance element; which comprises forming said resistance element on the lower face of the insulating substrate by a film-depositing method based on a dry process; wherein the resistance element has a thickness dispersion of ± 3 μm or less. (See Claim 17.)

(2) A process for producing a hot plate comprising an insulating substrate having an upper face and a lower face having surface roughness of 2 μm or less and a resistance element; which comprises forming said resistance element on the lower face of the insulating substrate by RF sputtering; wherein the resistance element has a thickness dispersion of ± 3 μm or less. (See Claim 27.)

(3) A process for producing a hot plate comprising an insulating substrate having an upper face and a lower face having surface roughness less than 2 μm and a resistance element; which comprises forming said resistance element on the lower face of the insulating substrate by printing a resistance element paste comprising scaly nobel metal powder and firing the resistance element paste; wherein the resistance element has a thickness dispersion of ± 3 μm or less. (See Claim 37.)

Each of these claims, and the claims dependent thereon, are believed to be novel and unobvious over the references of record.

The rejection of claims 14-16 under 35 U.S.C. § 103(a) over Matsumura et al. (U.S. 5,151,871) in view of Kawanabe et al. (U.S. 6,133,557), Thimm et al. (U.S. 5,560,851), Nakamori et al. (U.S. 4,849,605), Morita et al. (U.S. 5,118,983) or Tsuruta et al. (U.S. 5,554,839), either separately or in any combination, is respectfully traversed.

Claims 14, 15, and 16 are now cancelled and serve as the basis for new claims 17, 27, and 37, respectively. The rejections are discussed as a whole because neither Matsumura, Kawanabe, Thimm, Nakamori, Morita, nor Tsuruta suggest a process for producing a hot plate comprising an insulating substrate having an upper face and a lower face having a surface roughness of 2 μm or less and a resistance element; which comprises forming said resistance element on the lower face of the insulating substrate by a: film-depositing method based on a dry process (claim 17), by RF sputtering (claim 27), or printing a resistance element paste comprising scaly nobel metal powder and firing the resistance element paste (claim 37). It is requested that the Examiner withdraw this rejection in view of the amendments to the claims and the following comments.

Matsumura describes a process for heat-processing semiconductor device and apparatus for the same, in which a silicon wafer is heated by means of a conductive thin film by transmitting heat through an insulating substrate in accordance with information that is supplied by an external CPU (See Abstract, Figs. 4, 5A, and 6). As can be seen in Fig. 5A, the heat generated by the thin conductive layer (14) is transmitted through the insulating substrate (13) to the silicon wafer (W). Matsumura describes how temperatures have been controlled by forcedly cooling by means of a cooling unit (col. 1, ℓℓ. 43ff). In fact, Matsumura appreciates the problem of uniform heating (col. 1, ℓℓ. 43ff), and posits that uniform heating is enabled by having a thin conductive layer formed from a material "whose

electrical resistances become smaller as the temperature becomes higher or lower" (col. 3, ℓℓ. 61ff).

Kawanabe describes a wafer holding member in which a heating resistor is contained within a ceramic base body (See Abstract and Figs 4-6 and 10A). Kawanabe places the heating resistor within the body of the ceramic substrate in order to protect it from the corrosive environment that can occur when silicon wafers are processed. Kawanabe touches upon the compositional makeup of the heating resistor and the differential thermal expansion coefficients between the heating resistor and the ceramic base body, but does not describe or suggest a process of forming a resistance element on the surface of an insulating substrate having a surface roughness of 2 μm or less.

Thimm describes a process for producing an electric heating element, in which "metallic heating conductors are embedded between ceramic insulating layers" (see Abstract). Thimm describes a printing method for depositing a metallized paste to the surface of the ceramic insulating layer (col. 2, ℓℓ. 14ff). It appears that the only uniformity that Thimm is concerned with pertains to the uniformity of the strip conductors (col. 3, ℓℓ. 18ff and col. 3, ℓℓ. 55ff).

Nakamori describes a heating resistor deposited by an RF sputtering process (col. 5, ℓℓ. 17ff) on an insulating substrate, in which the subsequently formed component is evaluated with respect to a resistance variation rate ($\Delta R/R$; Figs. 3-4) as a function of the RF sputtering process. Nakamori's only contribution to the overall analysis is that its method of deposition of a metal onto an insulating substrate is via an RF sputtering process.

Morita describes a thermionic electron source that has a resistance element (2) that contacts a metal-oxide substrate (1) (2:1; Figs. 1-3) or contacts a non-oxide protective film (8) which contacts the metal-oxide substrate (2:8:1; Fig. 4). An aspect that was discussed with the Examiner on October 13, 2004, is that Morita contains an express teaching away

from the "roughness aspect" as presently claimed. For example, the Examiner's attention is directed to the text on col. 2, ℓℓ. 5-65. In particular, the aspect most pertinent to this discussion begins on col. 10, ℓ. 20. Morita describes that a non-oxide protective film (NOPF, **8**, see Fig. 4) comes in contact with the metal-oxide substrate and serves as a support for the resistance element; wherein both the NOPF and the metal-oxide substrate constitute the insulating substrate. A NOPF having a thickness of "several μm -100 μm" (col. 10, ℓ. 63ff) and made from AlN or BN may be used (col. 10, ℓ. 22). However, the most important feature of this entire passage is that the NOPF "is readily available in a monocrystalline state and...can be mirror finished by grinding on the surface *opposite the thin film resistive film*" (i.e., resistance element, col. 10, ℓℓ. 29-30, emphasis added herein). It is known that the NOPF is mirror finished by grinding on the side that contacts the metal-oxide substrate. Thus, grinding on the face of the NOPF opposite that of the resistance element will result in a reduction of the surface roughness of the face opposite that of the resistance element. Though not explicitly stated, it can be concluded that a reduction of the surface roughness on the NOPF face opposite to the resistance element is an important feature for this particular embodiment. Conversely, it can also be inferred that when Morita is silent with respect to grinding the NOPF on the face that contacts the resistance element; then it can be taken as an implicit suggestion that grinding the NOPF on the side that contacts the resistance element is unimportant for this particular embodiment.

This should be contrasted with the claimed invention in which it is important to have a surface roughness of 2 μm or less on the face of the insulating substrate in which the precursor form of the resistance element is formed. The importance of this feature can be better appreciated by inspecting the observed thickness dispersion, surface roughness and temperature dispersion that occurs as described for the prepared samples (S1 – S5), as presented in the following Table (pages 13-15).

Sample №	Thickness Dispersion μm	Surface Roughness μm	Temperature Dispersion °C
S1	+0.7	0.5	0.2
S2	+0.5	0.1	0.15
S3	-0.3	0.03	0.1
S4	+2.0	0.5	0.25
S5	+3.1	2.1	0.4

It should be clear from the data shown in the Table that as the surface roughness increases, so too does the observed temperature dispersion. A reduction of surface roughness of the face of the insulating substrate that contacts the resistance element may be achieved by polishing (page 13, lines 17ff); wherein the extent of surface roughness can be approximately controlled (page 14, lines 1-5).

Referring back to the discussion of Morita, it should be clear that Morita description suggests that grinding on the face of the NOPF which is opposite to the resistance element is important, but that grinding on the face of the NOPF that contacts the resistance element is unimportant. Seeing that this suggestion is in direct contrast to the claimed invention, the Examiner is requested to recognize that the claimed invention is unobvious in view of the references. Especially in view of this direct "teaching away."

Tsuruta contributes to the cumulative information of the cited references, but does not provide the missing link needed to sustain a prima facie case of obviousness. While Tsuruta is directed to aspects of a heating body embedded in a ceramic substrate in the application of an oxygen sensor, Tsuruta does not describe or suggest forming a resistance element on the surface of an insulating substrate whose surface roughness is 2μm or less. Tsuruta provides pictorial evidence for the roughness of a surface that does not make contact with a resistance element, which is depicted in the electron microscope photographs (Figs. 7-9) of an embodiment (Ex. 4) of the invention. While it is impossible to determine with precision the

actual surface roughness of the ceramic substrate that contacts the heating body (resistance element), due to the image quality, it is possible to estimate the surface roughness of the ceramic substrate opposite to the heating body (top portion of Fig. 7). Using the scale provided and a straight-edge one can approximate the peak-to-valley distance to be about 4.2 μm, which yields a root-mean-square-value of about 3 μm. But most importantly, the disclosure of Tsuruta never suggests that uniform heating of a sample may be controlled by reducing the surface roughness of the face of the ceramic, which contacts the resistance element, to a value of 2 μm or less. Instead, Tsuruta describes enclosing resistance elements within the body of a ceramic substrate, in which an entire face of the resistance element does not contact the surrounding ceramic substrate (See Fig. 3B); with the aim of reducing cation migration and not reducing temperature non-uniformity.

Accordingly, given that the cumulative disclosure fails to suggest that uniform heating may be achieved by controlling the surface roughness as described in each of claims 17, 27, and 37; it is believed that the claimed invention is unobvious in view of this cumulative disclosure. It is respectfully requested that the Examiner withdraw these rejections.

In view of the amendments to the claims, it is believed that claims 17-43 are in a condition for allowance. Should the Examiner deem that a personal or telephonic interview would be helpful in advancing this application toward allowance, he or she is encouraged to contact Applicant's undersigned representative at the below-listed telephone number.

Respectfully submitted,

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